An Evaluation of a Telepresence Robot: User Testing among Older Adults with Mobility Impairment

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ABSTRACT
For older adults with mobility impairment, maintaining health and wellness while aging-in-place independently is crucial. Telepresence technology, such as Kubi, can be potentially beneficial for this target population to stay socially connected [1]. However, the Kubi robot is not specifically designed for older adults with mobility impairment. For this target population to adopt the technology successfully, it is important to ensure that they would not experience usability barriers. Thus, we conducted usability testing of Kubi with five older adults with self-reported mobility impairment. The findings indicated both hardware and GUI problematic issues for this population. Hardware problems were primarily related to the base. GUI usability issues were caused by system visibility and control of the robot. These findings provide direction for improving the usability of telepresence robots, particularly for adults aging with mobility impairment.

Keywords
Telepresence; older adults; mobility impairment; user testing

1. INTRODUCTION
Older adults are defined as individuals aged 65 and above [2]. This segment of the population is growing rapidly [2] as more people are living longer [3]. However, 38.7% of older adults have reported having one or more disabilities [4]. Of these disabilities, ambulatory disabilities (i.e., difficulty with walking or climbing stairs) are the most frequent reported [4]. It is important to facilitate the health and independence of older adults with mobility impairments to sustain their health and aging-in-place. Mobility is a key component of maintaining independence [5]. As the older population grows, the proportion of older adults with mobility impairment will likely increase.

Kubi is a tablet robotic stand that uses interactive two-way video and audio for long-distance communication. Kubi allows a user to manipulate the angle of the head of the stand to create a more immersive experience. Other studies have been conducted to explore older users' attitude towards and acceptance of Kubi or similar telepresence technology (i.e., assessments of usefulness). In [1], participants all had positive first reactions toward the televideo technologies (Skype, Kubi and Beam). Participants identified several benefits of televideo technology, including visualization, feeling of "being there", and convenience [1]. However, concerns about ease of use [1] were also stressed by the participants. To investigate whether these perceived barriers translate into usability barriers we conducted usability testing on Kubi with older adults with mobility impairment.

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2. METHOD
The primary goal of usability testing is to improve the usability of a product that is being tested [6]. In this study, we recruited five older adults (3 males, 2 females, M=57.60 years of age; SD = 11.57) with self-defined mobility impairment. This sample size is typical for user studies [7]. Each participant reported using an ambulatory aid (e.g., manual wheelchair, electric wheelchair, and a cane) on a regular basis and having difficulty walking independently without an ambulatory aid.

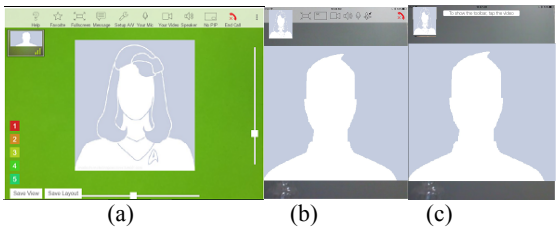
Each participant tested Kubi in a laboratory environment as both the pilot user (the remote operator) and the local user (the user co-located with the robot) by completing a list of tasks. As the pilot user, participants' tasks included: log into the system, initiate a call to a local user, send a message, delete a message and close chat window, mute/unmute the microphone and speakers, use various control methods (i.e., arrow key/mouse) to look around the room and save views, ask the pilot user to lock the Kubi, end the call, and finally, log off. As the local user, participants' tasks included: accept a video call, mute/unmute the microphone and speakers, lock the Kubi in the current position and final step, end the call. Questionnaires were administered to measure participants' perceived ease of use, usefulness, usability, and memorability of the system followed by open-ended questions that allowed participants to discuss their first impression and suggestions regarding design of telepresence systems.

3. RESULTS
When asked to rate the usefulness of Kubi (scale 1=extremely unlikely; 7=extremely likely), participants rated the system as "quite likely" to be useful (M=5.3, SD=.21). The participants' perception of ease of use was slightly higher (M=6.17, SD=.20). Nevertheless, we examined our usability results to determine whether these perceptions aligned with usability for this specific target population.

User Testing Hardware Issues - Participants perceived the tilt and pan feature of Kubi to be beneficial. One participant mentioned "when you have a group of people, turning function is nice. You want everyone to be able to communicate." However, 3

participants stated that the moving speed of Kubi was too fast and not adjustable. A concern was also mentioned that the fast turning motion could cause the pilot user to potentially experience motion sickness. One participant also felt that there was a learning curve for controlling the Kubi's motion, stating "it takes a little practice to figure out how little to move it to get it to do something." In addition, one participant also expressed the concern that the base of Kubi is unstable enough that it will be easy for their pets to knock over the device, and they would "need to find some place secure to put it and take it out when I was using it."

User Testing GUI Issues – With regard to the GUI, system visibility was an important design theme mentioned by the participants. All participants had comments on the design of the menu screen (for the local user). The menu bar disappeared after a period of "inactive" use (Figure1c). To change a setting, users have to tap the screen to make the menu bar reappear. Some of our participants not only reported lower mobility impairment, but also demonstrated impairment in using their hands. Therefore, tapping the screen every time before using the menu bar was problematic. However, for the pilot user, the menu bar was always present at the top of a computer screen (Figure1a). Participants stated that they liked the fact "that the menu is always there." The small font size of the menu text and the instructions was also problematic. "The font size is very small", one participant stated. As older adults might also experience visual impairment, a larger default font size or the ability to increase the size of the font would be useful for this population. Additionally, the color scheme is white and gray, which lead one participant to state that "I like more contrast, it's a little difficult to see."



(a) (b) (c)

Figure 1. Screen shots of Kubi GUI (a) computer screen, (b) tablet screen with menu bar and (c) tablet screen without menu bar

There were two methods to move Kubi by using the mouse: one using the two slide bars, where one was for panning Kubi left and right, and the other for panning up and down. Another method was to click on any spot on the screen and Kubi will move accordingly. However, some accidentally clicked on a spot, causing the device to turn unintentionally.

Kubi has a chat feature that allows the pilot user to send messages to local user. However, upon opening the chat window, a default message appears in the typing area, and the participant needs to delete the default message before they type their intended message. One participant commented "it will make more sense to have the instructions [the default message] disappear when you start typing your message." In addition, there was no enter button to send the message. Instead, the local user will see the message simultaneously as they pilot user is typing. One participant was confused how to send the message after he typed it, "I'm looking for an enter!" Another task that caused difficulty for the participants was closing the chat window. This is because there is a "X" sign on the chatting window, which all participants at first tried to click. However, this button does not close the window; the user instead needed to click the message icon again.

Kubi has the feature "save view." which allows a pilot user to save a position in the robot and mark that location with a number. Later, instead of manually returning the Kubi to that position, the user just needs to click the corresponding number and Kubi will return to it automatically. Our participants had a positive response to this feature. We marked 4 places in the testing room and asked each participant to control the Kubi to find each marked position and save each position to the corresponding number. However, Kubi does not allow a user to save a position as view 2 before view 1 is saved.

The local user can lock the Kubi to the current position to prevent the pilot user from turning. One task involved asking participants to lock the Kubi to its current position. Our participants struggled to finish the task, since the meaning of the icon of this feature was not intuitive to them. One participant reported, that "if it's just a lock, it would be obvious." In addition, there was no indication to show the pilot user whether the Kubi is locked.

4. Discussion

Kubi has the potential to help older adults with mobility impairment age-in-place. Indeed, research suggests that this population perceives the usefulness of televideo technologies [1]. However, Kubi is not specifically designed for older adults with mobility impairment. The capabilities of these potential users should be taken into consideration. To discover usability problems for the intended population, we conducted usability testing on Kubi with five older adults with mobility impairments, and issues reported from the testing were categorized into hardware and GUI problems. The user testing results indicate that our participants liked the turning feature of Kubi, however, the un-adjustable fast moving speed was problematic. There was also a learning curve to control Kubi. Participants were also concerned that Kubi is not stable enough for in a home environment. System visibility was a key component for users to know the current status of the system, and having clear and intuitive menu options would be beneficial for the target user to use the system easily and fluently.

For older adults with mobility impairments, Kubi can be beneficial to keep them socially connected. Conducting usability testing with people from this target user group can help us examine the usability issues with the system, and in the future, we aim to improve the ease of use of Kubi for our intended user.

5. REFERENCES

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